CLAIMS

1. A method of estimating a curvature of a roadway, comprising:

   a. generating a speed measurement by measuring a longitudinal speed of a host vehicle traveling on the roadway;

   b. generating a yaw rate measurement by measuring or determining a yaw rate of said host vehicle; and

   c. estimating at least one curvature parameter, wherein said at least one curvature parameter is representative of a curvature of the roadway, and the operation of estimating at least one curvature parameter is responsive to said speed measurement and is responsive to said yaw rate measurement.

2. A method of estimating a curvature of a roadway as recited in claim **1**, wherein said at least one curvature parameter comprises at least one parameter of a clothoid model of curvature, and said clothoid model of curvature is referenced to a coordinate system of said host vehicle.

3. A method of estimating a curvature of a roadway as recited in claim **2**, wherein said at least one curvature parameter comprises first and second parameters of a clothoid model, wherein said first parameter is a constant, and said second parameter is a sensitivity of curvature to a distance along the roadway.

4. A method of estimating a curvature of a roadway as recited in claim **1**, wherein the operation of estimating at least one curvature parameter comprises processing said measurements of speed and angular rate with at least one Kalman filter.

5. A method of estimating a curvature of a roadway as recited in claim **1**, wherein said at least one Kalman filter comprises first and second Kalman filters, said first Kalman filter is adapted to estimate a first set of state variables from said speed measurement and from said yaw rate measurement, and said second Kalman filter is adapted to estimate said at least one curvature parameter from said estimate of said first set of state variables.

6. A method of estimating a curvature of a roadway as recited in claim **5**, wherein said first set of state variables comprises vehicle velocity, vehicle acceleration, vehicle yaw rate and vehicle yaw acceleration.

7. A method of estimating a state of a target vehicle on a roadway, comprising::

a. generating an estimate of a curvature of the roadway;

b. estimating an unconstrained state and associated covariance thereof of the target vehicle;

c. establishing at least one prospective constraint of the target vehicle, wherein at least one prospective constraint is responsive to said estimate of the curvature of the roadway;

d. estimating at least one constrained state and associated covariance thereof of the target vehicle corresponding to said at least one prospective constraint of the target vehicle;

e. determining a most likely state of the target vehicle, wherein said most likely state of the target vehicle is selected from said unconstrained state of the target vehicle and said at least one constrained state of the target vehicle; and

f. if said at least one constrained state of the target vehicle is the most likely state, then fusing the unconstrained state and covariance thereof of the target vehicle with the associated constrained state and covariance of said most likely state and outputting at least one of the fused state and the associated fused covariance thereof of the target as the estimated state or covariance of the target; otherwise outputting at least one of the unconstrained state and the associated unconstrained covariance thereof of the target as the estimated state or covariance of the target.

8. A method of estimating a state of a target vehicle on a roadway as recited in claim 7, wherein the operation of estimating the curvature of the roadway comprises:

a. generating a speed measurement by measuring a longitudinal speed of a host vehicle traveling on the roadway;

b. generating a yaw rate measurement by measuring or determining a yaw rate of said host vehicle; and

c. estimating at least one curvature parameter, wherein said at least one curvature parameter is representative of a curvature of the roadway, and the operation of estimating at least one curvature parameter is responsive to said speed measurement and is responsive to said yaw rate measurement.

9. A method of estimating a state of a target vehicle on a roadway as recited in claim **8**, wherein said at least one curvature parameter comprises at least one parameter of a clothoid model of curvature, and said Clothoid model of curvature is referenced to a coordinate system of said host vehicle.

10. A method of estimating a state of a target vehicle on a roadway as recited in claim **9**, wherein said at least one curvature parameter comprises first and second parameters of a clothoid model, wherein said first parameter is a constant, and said second parameter is a sensitivity of curvature to a distance along the roadway.

11. A method of estimating a state of a target vehicle on a roadway as recited in claim **8**, wherein the operation of estimating at least one curvature parameter comprises processing said measurements of speed and yaw rate with at least one Kalman filter.

12. A method of estimating a state of a target vehicle on a roadway as recited in claim **11**, wherein said at least one Kalman filter comprises first and second Kalman filters, said first Kalman filter is adapted to estimate a first set of state variables from said speed measurement and from said yaw rate measurement, and said second Kalman filter is adapted to estimate said at least one curvature parameter from said estimate of said first set of state variables.

13. A method of estimating a state of a target vehicle on a roadway as recited in claim **12**, wherein said first set of state variables comprises vehicle velocity, vehicle acceleration, vehicle yaw rate and vehicle yaw acceleration.

14. A method of estimating a state of a target vehicle on a roadway as recited in claim **7**, wherein the operation of estimating an unconstrained state and associated covariance of the target vehicle comprise:

a. measuring a range, a range rate and an azimuth of the target vehicle relative to a host vehicle; and

b. estimating said unconstrained state of the target vehicle from said measurements of the range, range rate and azimuth of the target vehicle relative to the host vehicle.

15. A method of estimating a state of a target vehicle on a roadway as recited in claim **7**, further comprising the operation of transforming said unconstrained state of the target vehicle to a coordinate system corresponding to said estimate of the curvature of the roadway.

16. A method of estimating a state of a target vehicle on a roadway as recited in claim **7**, wherein said at least one prospective constraint of the target vehicle is applied to a lateral position of the target vehicle, and a longitudinal position of the target vehicle is unconstrained.

17. A method of estimating a state of a target vehicle on a roadway as recited in claim **7**, wherein said at least one prospective constraint of the target vehicle comprises a plurality of prospective constraints, and at least two different prospective constraints correspond to different lanes of the roadway.

18. A method of estimating a state of a target vehicle on a roadway as recited in claim **7**, wherein the operation of determining the most likely state of the target vehicle comprises:

a. determining at least one likelihood value, wherein said a least one likelihood value corresponds to said at least one prospective constraint of the target vehicle being active and said at least one likelihood value is responsive to a corresponding at least one distribution function evaluated at a value corresponding to said unconstrained state of the target vehicle;

b. determining a probability of a first constrained state of the target vehicle, wherein said probability is responsive to said at least one likelihood value;

c. testing at least one hypothesis that said unconstrained state of the target vehicle corresponds to said first constrained state, and

d. identifying a most likely state of the target vehicle responsive to the operation of testing said at least one hypothesis.

19. A method of estimating a state of a target vehicle on a roadway as recited in claim **18**, wherein the operation of determining the most likely state of the target vehicle comprises establishing at least one a priori probability of a transition from a first state to a second state of the target vehicle, wherein said first and second states can be either the same or different states, and said probability of said first constrained state of the target vehicle is responsive to said at least one a priori probability.

20. A method of estimating a state of a target vehicle on a roadway as recited in claim **18**, wherein said at least one distribution function is responsive to said covariance of the particular constrained state of the target vehicle.

21. A method of estimating a state of a target vehicle on a roadway as recited in claim **18**, wherein said at least one constrained state comprises a plurality of constrained states, and said first constrained state comprises a combination of said plurality of constrained states.

22. A method of estimating a state of a target vehicle on a roadway as recited in claim **18**, wherein said first constrained state comprises a most likely of said at least one constrained state of the target vehicle.

23. A method of estimating a state of a target vehicle on a roadway as recited in claim **18**, wherein said first constrained state comprises one of said at least one constrained state of the target vehicle.

24. A method of estimating a state of a target vehicle on a roadway as recited in claim **18**, wherein the operation of testing at least one hypothesis is responsive to the most recent estimates of said state of the target vehicle.

25. A method of estimating a state of a target vehicle on a roadway as recited in claim **18**, wherein the operation of testing at least one hypothesis comprises identifying a particular constrained state of the target vehicle corresponding to a most likely of said at least one constrained state of the target vehicle, calculating a value of a function responsive to a difference between said unconstrained state and said particular constrained state, and comparing said value of said function with a threshold, whereby said hypothesis is satisfied if said value of said function is less than said threshold.

26. A method of estimating a state of a target vehicle on a roadway as recited in claim **25**, wherein said threshold is responsive to the particular constraint associated with said particular constrained state of the target vehicle.

27. A method of estimating a state of a target vehicle on a roadway as recited in claim **26**, wherein said threshold is relatively lower for said particular constrained state corresponding to an increased threat by the target vehicle to host vehicle.

28. A method of estimating a state of a target vehicle on a roadway as recited in claim **27**, wherein said particular constrained state corresponding to an increased threat by the target vehicle to the host vehicle is selected from the target vehicle moving in the same lane as the host vehicle, and the target vehicle changing lanes to said same lane as the host vehicle.

29. A system for estimating a curvature of a roadway, comprising:

a. a speed sensor adapted to measure a longitudinal speed of a vehicle on the roadway;

b. a yaw rate sensor adapted to measure a yaw rate of said vehicle; and

c. a processor operatively coupled to said speed sensor and to said yaw rate sensor, wherein said processor is adapted to estimate a curvature of the roadway responsive to measurements from said speed sensor and from said yaw rate sensor.

30. A system for estimating a curvature of a roadway as recited in claim **29**, wherein said processor comprises at least one Kalman filter, and said at least one Kalman filter is adapted to generate an estimate of at least one curvature parameter responsive to said measure of longitudinal speed and responsive to said measure of yaw rate, wherein said at least one curvature parameter is representative of a curvature of the roadway.

31. A system for estimating a curvature of a roadway as recited in claim **30**, wherein said at least one Kalman filter comprises first and second Kalman filters, said first Kalman filter is adapted generate an output comprising estimates of yaw rate, yaw acceleration, longitudinal speed and longitudinal acceleration, responsive to said measures of longitudinal speed and yaw rate; and said second Kalman filter is adapted to generate said estimate of said at least one curvature parameter responsive to said output from said first Kalman filter.

32. A system for estimating a state of a target vehicle on a roadway, comprising:

a. a road curvature estimation subsystem for estimating a curvature of a roadway upon which a host vehicle is traveling;

b. a target state estimation subsystem operatively coupled to said host vehicle, wherein said target state estimation subsystem is adapted to track the target vehicle on the roadway; and

c. at least one processor operatively coupled to or a part of said road curvature estimation subsystem and said target state estimation subsystem, wherein said processor is adapted to determine if the target vehicle is likely traveling in a particular lane of the roadway, responsive to said curvature estimated by said road curvature estimation subsystem, and responsive to a measure of target kinematics from said target state estimation subsystem.

33. A system for estimating a state of a target vehicle on a roadway as recited in claim **32**, wherein said road curvature estimation subsystem for estimating the curvature of the roadway comprises:

a. a speed sensor adapted to measure a longitudinal speed of said host vehicle on the roadway; and

b. a yaw rate sensor adapted to measure a yaw rate of said host vehicle on the roadway, wherein said at least one processor is operatively coupled to said speed sensor and to said yaw rate sensor, and said processor is adapted to estimate a curvature of the roadway responsive to measurements from said speed sensor and from said yaw rate sensor.

34. A system for estimating a state of a target vehicle on a roadway as recited in claim **32**, wherein said target state estimation subsystem comprises a radar system operatively coupled to said host vehicle.

35. A system for estimating a state of a target vehicle on a roadway as recited in claim **32**, wherein said processor comprises an extended Kalman filter adapted to estimate a measure of target kinematics responsive to measures of range, range rate and azimuth angle of said target state estimation subsystem.

36. A system for estimating a state of a target vehicle on a roadway as recited in claim **35**, wherein said measure of target kinematics comprises a measure of target position relative to a coordinate system of the host vehicle.

37. A system for estimating a state of a target vehicle on a roadway as recited in claim **36**, wherein said measure of target kinematic further comprises a measure of target velocity relative to said coordinate system of the host vehicle.